Chemical Speciation Imaging at Environmentally Relevant Concentrations using X-ray Fluorescence Microscopy

David Paterson[a], Daryl L. Howard[a], Martin D. de Jonge[a], Kathryn M. Spiers[a], Chris G. Ryan[b], Robin Kirkham[b], Barbara E. Etschmann[c], Enzo Lombi[d], Erica Donner[d], and Peter M. Kopittke[e]

[a]Australian Synchrotron, Australia, [b]CSIRO, Clayton, Australia, [c]Monash University, Australia, [d]University of South Australia, Australia, [e]University of Queensland, Australia

Author Email: david.paterson@synchrotron.org.au

Abstract

X-ray fluorescence microscopy (XFM) [1] can be used for elemental and chemical microanalysis across length scales ranging from millimeter to nanometer. XFM is ideally suited to quantitatively map trace elements within whole plant and other biological specimens, environmental and soil samples. The elemental sensitivity of the X-ray fluorescence probe provides valuable information in a diversity of environmental sciences, and the high penetration of hard X-rays enables measurement of whole cells, tissue sections and a diverse range of environmental samples with a minimum of preparation.

Rapid advances in X-ray fluorescence detection methods such as the Maia detector [2, 3, 4] now enable high definition images approaching megapixel per minute rates. The ability to rapidly acquire 2D images enables 3D information such as fluorescence tomography to be obtained in realistic times. Chemical speciation (valence) imaging (CSI) is a technique where the third dimension is spectroscopic detail [5]. CSI results in an X-ray Absorption Near Edge Structure (XANES) spectra from the X-ray fluorescence signal at each pixel in the spatial image.

Fitting of spectra per pixel with incident X‑ray energy tracking and end-member phase decomposition has recently been developed in GeoPIXE software using the Dynamic Analysis method [6, 7, 8].

CSI has been demonstrated at the Australian Synchrotron XFM beamline [1] with micron resolution and moderate definition (10K pixels) across a diverse range of sciences and applications from environmental chemistry [9] to arsenic toxicity in crop production [10]. Studies probing and optimising the efficiency and sensitivity of CSI to achieve measurements at environmentally relevant concentrations will be presented.

References

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